*January* 26, 1888.

Professor G. G. STOKES, D.C.L., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "The Emigration of Amœboid Corpuscles in the Starfish." By HERBERT E. DURHAM, B.A., lately Vintner Exhibitioner, King's College, Cambridge. Communicated by P. HERBERT CARPENTER, D.Sc., F.R.S., F.L.S. Received January 5, 1888.

[PLATE 3.]

Through the kindness of Professor M'Intosh, to whom my very best thanks are due, I spent some time last summer at the Marine Laboratory at Saint Andrews.

The results given below arose from what were intended to be control experiments in some observations which aimed at determining, if possible, what organ or system of organs is definitely excretory in function in the Echinoderms.

The common starfish (*Asterias rubens*) was the form used, being convenient both from its size and from its abundance.

Indian ink or a precipitated aniline blue was injected into the cœlomic cavity by means of a fine pipette or a hypodermic syringe. It was found best to insert the instrument into an arm close to the disk, for then the arm is far more rarely thrown off than if the puncture is made near its distal end. The specimen was next held in different positions so as to distribute the injected fluid.

The granules that are introduced are ingested by the amœboid corpuscles which float in the cœlomic fluid, as can readily be demonstrated by microscopic examination of that fluid. The granule-laden phagocytes can be seen very plainly, owing to the particles they have ingested, in the dermal branchiæ of a living specimen. The cilia of the cœlomic epithelium cause them to dance up and down in the branchia, and to be thrown against its wall. Every now and again a corpuscle will adhere, and by repetition of this process a small clump may be formed; this occurs at or near the apex of the branchia.



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The corpuscles after their adhesion to the wall of the branchia creep by their amœboid movement through the cœlomic epithelium, the connective tissue layer, and the epidermis to the exterior (fig. 1). Thus a clump may be formed on the outer side of the branchia, and the animal is freed from some of the irritating particles.

In these clumps the corpuscles retain their individuality (fig. 2), they do not fuse to form plasmodia such as Geddes* describes in the so-called clotting of the perivisceral fluid of urchins; indeed if such a coalescence did take place the facility for their migration through tissues would be considerably diminished.

In cases where the emigration is proceeding exceedingly actively, besides the isolated phagocytes that are seen at different depths in the branchial wall on their outward journey, the apices of some of the branchiæ appear to be perforated by an aperture, which is entirely filled up by a plug of phagocytes (fig. 3, *p*). It is clear that such a result might be due either to a stretching of the wall by a simultaneous entrance of several phagocytes at a certain point and subsequent intrusions of others between them, or to an actual rupture or carrying away of part of the wall by the energy and magnitude of the emigration round one patch. So far as can be made out from serial sections the former of these alternatives holds good; there seems, however, to be no reason why the latter might not also take place.

Since in preparing Echinoderms for sections it is usual to distend them with the fixing fluid, I should mention that here such treatment has been avoided. The specimens were anæsthetisized with chloral hydrate, and the gills could then be removed in a distended state, while moreover they remained distended after removal.

To return to the subject: after their arrival at the exterior the corpuscles retain their irregular amœboid shape for a time. They then become spherical and swell up and later they disintegrate, the granules they contained being scattered free.

It was found that besides the corpuscles containing Indian ink particles in the extruded material, there occurred amœboid cells loaded with refringent granules (fig. 2, *b*); moreover it is not only in the injected specimens that such corpuscles emigrate; for if a starfish is kept in a vessel (into which fresh sea-water is constantly dripping) it throws off from its surface a certain amount of a dirty brownish slime. This slime contains large corpuscles with refringent granules (fig. 4) which are apparently identical with those mentioned above, and with those peculiar cells which occur here and there in different parts of the animal, especially perhaps in the so-called "heart;" they are called "Plasma-Wanderzellen" by the Germans: I propose to refer to them as "sphæruliferous" corpuscles.

* 'Archives de Zoologie Expérimentale,' vol. 8, p. 483.

In the slime these sphæruliferous corpuscles are seen in various stages of disintegration, held together by a material of slimy consistency which is, at any rate in part, derived from the swollen-up stromata of the corpuscles, some doubtless having origin in the scattered mucous gland cells of the epidermis. Besides these elements a holotrichous infusorian occurred, frequently in considerable numbers, swimming about and feeding on the freely scattered granules. In connexion with this I might also note that on a large percentage of the specimens of *Asterias rubens* observed at Saint Andrews there crawled a species of *Caprella*. These Caprellæ feed on the above-mentioned slime; and those which lived on specimens treated with aniline blue presented particularly gay alimentary canals.

As regards the emigration of these sphæruliferous cells, it is interesting to find that Hamann* has recently described and figured the presence of such corpuscles in the wall of the ambulacral gills of Echinids; these are doubtless on their outward journey. I might also note here that when the dermal branchiæ of *Asterina gibbosa* are slightly, not rigidly, distended, they move round and round, more or less circularly, so that their apices rub against the neighbouring ossicles. This movement might be interpreted as the expression of attempts to remove emigrated corpuscles from their surface; the branchiæ when removed showed sphæruliferous cells in their wall.

I hope to make further observations to help to elucidate the meaning of this out-wandering of sphæruliferous cells, about which at present it is impossible to draw up any definite conclusions. I desire now merely to note its occurrence.

It seems evident, however, that the starfish has the power of removing minute foreign particles introduced into its system; and it is conceivable that in nature such particles might gain admittance to the cœlomic cavity when an arm is thrown off.

It does not seem clear what becomes of insoluble foreign granules when they are introduced into other animals, except in the case of mammals; at any rate I have been unable to find any account of an actual transportation to the exterior such as has been described above.

Over and above any respiratory function that the dermal branchiæ may have, they form from their structure convenient places for the out-passage of scavenging amœboid cells. Hamann† notes that their nerve supply is very scanty; the well-being of a fine nerve plexus would obviously not be added to by amœboid cells traversing it.

To summarise in a few words—minute foreign bodies introduced into the body-cavity of the starfish are removed to the exterior by

* 'Jenaische Zeitschrift,' vol. 21, p. 159, and Taf. VI, fig. 12.

† 'Die Asteriden,' Jena, 1885 (p. 11).

phagocytes which pass out through the dermal branchiæ. In conclusion, I should state that clumps of corpuscles occur, here and there, in the pore canals of the madreporite both of *Asterias rubens* and *Cribrella ocellata* as seen in sections. The madreporites and neighbouring structures were removed from full-grown specimens and then placed in hardening fluids: this being so, I think it not improbable that these corpuscles came from the cut end of the "heart," and arrived at their position by the outward ciliary current, recently described by Dr. Hartog.* It is difficult to conceive that such an outflow of corpuscles should take place normally; for then there must be a continual loss of *ordinary* as well as of *sphæruliferous corpuscles*.

EXPLANATION OF PLATE 3.

FIG. 1.—Section through a dermal branchia of *Asterias rubens*, after Indian ink injection. *c. e.*, cœlomic epithelium; *c. t.*, connective tissue; *e*, epidermis; *cut.*, cuticle.

FIG. 2.—Corpuscles containing granules of Indian ink, taken off a branchia. *b*, sphæruliferous corpuscle.

FIG. 3.—Section through terminal portion of dermal branchia. Note the plug of corpuscles (*p*) and crowding of epiderm nuclei at its sides. The other letters as in fig. 1.

FIG. 4.—Sphæruliferous cells from slime. *l*, liberated sphærules.

II. "Note on the Madreporite of *Cribrella ocellata*." By HERBERT E. DURHAM, B.A., lately Vintner Exhibitioner, King's College, Cambridge. Communicated by P. HERBERT CARPENTER, D.Sc., F.R.S., F.L.S. Received January 5, 1888.

I have a series of vertical longitudinal (radial) sections carried through the madreporite, &c., of a full-grown specimen of *Cribrella ocellata*: in this series the madreporic canals have a peculiar relation to the stone canal or water-tube.

Most of the pore canals pass into collecting canals which open into the stone canal directly: some few, however, lead into the space below the madreporite, which is the upper extremity of the "schlauchförmiger Kanal." The stone canal dilates laterally on each side into an "*ampulla*," and one of these lateral lobes of the ampulla has an aperture into the "schlauchförmiger Kanal." Now the "schlauchförmiger Kanal" is derived from the enterocœle (Hamann),† so that in the specimen described there is a permanent connexion between the hydrocœle cavity and the enterocœle cavity.

* M. M. Hartog, 'Ann. Mag. Nat. Hist.,' Nov. 1887.

† O. Hamann, 'Die Asteriden,' p. 51, Jena, 1885.